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A reappraisal of the Lurøy, Norway, earthquake of 31 August 1819

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Abstract

Archives and libraries were visited to find previously unknown documents testifying to the Lurøy, Norway, earthquake of 31 August 1819 in northernmost continental Europe. The focus here is on Sweden, Finland, and Russia, which are important for determining the area of perceptibility east of Norway. The new written sources include 12 notes or entries in original archived documents, six contemporary newspaper reports, and two recollections written down years later. The original documentation uncovered is contributory to establishing the authenticity of the observations in Finland and Sweden. The dates of the original documentation allow tracing of the dissemination of eyewitness accounts in writing from the inner area of perceptibility southward to the larger documentation and population centers. New sources of information include weather reports of the Royal Swedish Academy of Sciences, minutes of its meetings, and correspondence sent to the Senate in Finland. The minutes of meetings of the Academy indicate that ample data were collected in the Swedish province of Västerbotten. We found no original Russian documentation, but uncovered national newspapers are more reliable than the previously used Parisian newspaper.

To increase transparency we provide the first list of macroseismic data points (MDPs) including the respective documentation that testify to the Lurøy earthquake. A macroseismic intensity was assigned to a locality, using the European Macroseismic Scale of 1998, when adequate information was available. Accounting for the uncertainty of intensity assessment, the magnitude was estimated as moment

magnitude **M** = 5.9 ± 0.2, reconfirming the ranking as the largest onshore/nearshore earthquake in the historical seismicity record of Fennoscandia. In addition to the reappraisal of the 31 August 1819 earthquake, a macroseismic map is also provided for the earthquake of 17 February 1819, which was felt in northern Finland and Sweden. Some of its MDPs were previously associated with the Lurøy earthquake.

Introduction

The seismic hazard analyses mandatory for critical constructions are a major reason behind the need for earthquake catalogs covering both the pre-instrumental and instrumental eras, at plate boundaries and continental interiors alike. The pre-instrumental seismicity record in northernmost continental Europe (Fennoscandia; Fig. 1) only spans a few centuries but is sufficient to demonstrate that earthquakes with larger areas of perceptibility have occurred in the past, although they have not occurred during the instrumental era.

This investigation focuses on the earthquake of 31 August 1819 in Norway. Its epicenter is estimated to have been near Lurøy, on the coast of Nordland, Norway (Fig. 1). Macroseismic maps have been published by Ambraseys (1985) and Muir Wood and Woo (1987). The latter map was republished by Muir Wood (1988) and will serve as the main macroseismic reference in this investigation. Ambraseys (1985) and Muir Wood (1988) made use of historical records, the contemporary press, seismological compilations, and travelers' accounts. Ambraseys (1985 p. 370) even sent an open letter to the Swedish press calling for unpublished information on the Lurøy earthquake but received a poor response. They estimated the maximum intensity to be 8 on the Medvedev–Sponheuer–Kárník (MSK) and Modified Mercalli Intensity (MMI) scales. They showed that the Lurøy earthquake had an exceptionally large area of perceptibility that extended over many territories. Muir Wood and Woo (1987 p. 45) estimated the magnitude to be M_S5.8 on the basis of the radius of perceptibility corresponding to I = 4 (MMI). This value makes it the largest

onshore/nearshore earthquake in the historical seismicity record of Fennoscandia. Husebye and Kebeasy (2004) suggested lowering the magnitude to M_S5.1 (and M_L4.8), which gave reason for comments (Wahlström 2004; Bungum and Olesen 2004, 2005; Husebye and Kebeasy 2005; Husebye 2005). Their study placed emphasis on the interpretation of known reports and the lack of reports from several localities, rather than the search for additional documentation.

Uncovering more evidence of the Lurøy, Norway, earthquake is not a trivial undertaking, however. Northern Fennoscandia was not densely populated, and the distribution of settlements is affected by the rough topography. The native Sámi people living in northern Norway, Sweden, Finland, and Russia (Lapland) did not produce written information. Writing skills were not common in the region at the time (Mäntyniemi 2017b). Persons whose official position demanded writing would report on pertinent matters on behalf of peasants, but such an administrative system is no paragon of spontaneous writing on earthquakes. Authorities would have been compelled to step in when ground shaking damaged public property.

Swedish vicars were obliged to report on rare natural phenomena except for a period between 1802 and 1820 (Sidenbladh 1908 p. 119). The Swedish Statistical Office (a predecessor to Statistics Sweden) was established in 1749 and shortly thereafter designed its first questionnaire, which included an item for unusual natural phenomena. Sidenbladh (1908) found over one hundred notifications of ground shaking in the filled-in questionnaires in Sweden and Finland from 1749 to 1801 and in Sweden alone from 1821 to 1859.

Musson (1986) and many later authors have made use of contemporary newspaper reports, especially to investigate earthquakes for which no systematic macroseismic surveys were conducted. Newspapers published inside the area of perceptibility are particularly promising sources of earthquake reports (Mäntyniemi 2017a p. 10). In 1819, however, only one newspaper was published in Trondheim, central Norway; otherwise, the newspapers in the region consisted of titles published in the largest towns in the south (Fig. 1).

In this investigation, archives and libraries were visited to find previously disregarded documents and to confirm existing data points of the Lurøy, Norway, earthquake of 31 August 1819. Much attention has previously been paid to uncovering data in Norway in order to assess the seismic potential of the North Sea (Muir Wood et al. 1985; Bungum et al. 1986; Bungum and Selnes 1988). The focus here is on the territories of Sweden, Finland, and Russia, which are important for determining the area of perceptibility east of Norway. The new findings are presented, intensities are assessed and maps prepared, the macroseismic magnitude is estimated, and the results are discussed.

New data and revisions

The new documents include 12 notes or entries in original archived documents, six contemporary newspaper reports, and two recollections written down years later. They can be found in their original languages with translations into English in the electronic supplement to this article.

Sweden

Minutes of the meetings of the Royal Swedish Academy of Sciences tell us about the exchange of letters between Stockholm and the county of Västerbotten in northern Sweden. County governor Georg Lars af Schmidt (1771–1842; Fig. 2a) sent reports of earthquake effects observed in the town of Umeå and its surroundings on 31 August to the Academy in Stockholm. When they were read at the Academy meeting on 22 September 1819 many members (out of the 21 attending) reacted by telling that they observed a similar natural phenomenon in Stockholm and in the countryside at the same hour. Reports collected in Stockholm by Academy member Jonas Henrik Gistrén (1767–1847; Fig. 2b) and in Västerbotten by governor af Schmidt were read at the next meeting on 27 October. When the newspaper *Inrikes Tidningar* on 24 November published reports on earthquake observations from Västerbotten, these may in fact have been based on the reports by governor af Schmidt, although this cannot be established as the reports are no longer available. The third report from the governor was read at the Academy on 2 February 1820. The municipality council in Sorsele held a meeting on 29 November 1819, and the minutes tell us that Sorsele was one locality in Västerbotten from where felt reports were forwarded to governor af Schmidt.

Other uncovered sources include an excerpt of a letter dated 27 November 1819 in Gällivare, northern Sweden, published in the Swedish newspaper *Stockholms Posten* on 29 December 1819: *On the afternoon of 31 August an earthquake occurred here,*

so that dwellings shook violently. Lapp people, who at that time camped up in the mountains close to the Norwegian border, report how they experienced the same natural phenomenon and were astonished and amazed by it, and that pots and pans clattered together in their huts, and even the most insignificant shrubs visibly moved.

The first part was possibly derived from an eyewitness in Gällivare, and the second part was derived from Sámi eyewitnesses who were up in the mountains when the earthquake occurred. It is possible that they passed through Gällivare on their way from the summer to the winter camp and communicated their sensations of ground shaking there. Their encampment close to the Norwegian border cannot be located precisely, so the village of Nikkaluokta (established around 1910) in the municipality of Gällivare is taken as its proxy.

The Royal Swedish Academy of Sciences had a network of weather observers. Intermittent time periods of the collected annual weather statistics from several localities have survived to this day, and three remarks on the earthquake on 31 August 1819 were found among them. Two accounts were provided by weather observers in the town of Umeå and its surroundings. The place of origin of the third account is Övertorneå, which is a new data point.

Two earthquakes, on 29 and 31 August, are mentioned only in the reports from Sorsele and Åsele in Sweden, so the first earthquake was probably not felt over a large area.

Finland

Ambraseys (1985) and Muir Wood (1988) used the Finnish newspaper *Åbo Tidningar* ("Åbo Papers") of 15 January 1820 as their source for Tornio (in Swedish *Torneå*), northern Finland. Muir Wood (1988 p. 229) attributed the newspaper article to general practitioner and ornithologist Lars Johan Prytz (1789–1823), whose field trip to northern Finland almost coincided with the earthquake. This was accepted by Mäntyniemi et al. (2011); however, the newspaper article was composed of administrative documents (Teerijoki 2007).

The main reports were written by the mayor of Tornio, Ephraim Cajanus, and district bailiff Jakob Heickell on 3 and 10 September 1819, respectively. Their reports were sent to the governor in Oulu and forwarded from there to the Senate in Helsinki. The principal purpose of the reports was to describe his majesty's stay in the town: the Russian tsar Alexander I was paying a visit to Finland at the time and arrived in Tornio on the evening of 31 August. The earth shook while the town's residents were waiting for the tsar's retinue. Swedish weather observer Johan Portin also described his earthquake observations in Tornio. The newspaper article devoted much space to the earthquake of 17 February 1819, originally described by district bailiff Heickell.

New earthquakes may launch recollections of old ones: a reminiscence appeared in Kalajoki in the province of Ostrobothnia after an earthquake in 1882 (Mäntyniemi and Wahlström 2013). It very likely refers to the Lurøy earthquake of 1819.

Three data points have been removed. No remark about Åbo, southern Finland (in Finnish *Turku*; 60.45° N and 22.26° E) could be found. According to Ambraseys (1985 p. 374), the shock was barely felt there. The newspaper *Åbo Tidningar* reported

on the earthquake effects in northern Finland, and possibly by mistake Åbo became a place where the earthquake was felt. Shaking in Muonio (67.96° N and 23.68° E), northern Finland, was attributed to the main shock of 31 August 1819 by Ambraseys (1985 p. 372). On the map by Muir Wood (1988), redrawn by Bungum and Olesen (2004 p. 247), the northernmost locality in Finland is Kittilä (67.65° N and 24.91° E). However, the ground shaking observed in Kittilä and the negative information reported from Muonio belong to 17 February 1819 (Fig. 3). Ambraseys (1985 p. 374) claimed that this earthquake was felt also in Norway, but we have not been able to verify this information.

Russia

According to Ambraseys (1985 p. 372), the town of Kola in the Russian North was the easternmost locality from which the earthquake of 31 August 1819 was reported. The source is the Parisian newspaper *Le Moniteur Universel* of 20 November 1819, also known to Perrey (1845 p. 35). The French government had agents, ambassadors, and emissaries whose task was to report news from various countries and have it published in *Le Moniteur Universel*. The piece of news stated that the ground shaking was strong enough to overturn tables, chairs, and other furniture. Given the distance of almost 900 km from Lurøy to Kola, such effects appear exaggerated. Ambraseys (1985 p. 374) took “overturning” to be erroneous but kept the locality, whereas Muir Wood (1988 p. 234) assumed that the report originated from somewhere closer to the epicenter and excluded Kola from his map.

We found four Russian newspapers reporting on ground shaking in Kola at a befitting time: *Le Conservateur Impartial* (the newspaper of the Ministry of Foreign Affairs), *St. Petersburgische Zeitung* ("St. Petersburg Newspaper"), and Сѣверная почта ("Northern Post") were published in St. Petersburg (the Russian capital at the time), and Московские Ведомости ("Moscow Gazette") was published in Moscow. The accounts published in these newspapers gave the time of observation as 19 August (old style, by the Julian calendar) at 4:30 in the afternoon. At the time, the time lapse between the old and new styles was 12 days. In Saltdal parish in Nordland, Norway, the local time of day was given as 2:30 (newspaper *Den Norske Rigstidende* 15 October 1819) and in Tornio, Finland, as between 3 and 4 (report by mayor E. Cajanus) or as 3 (district bailiff J. Heickell), in Åsele Lappmark as 3:45 (*Inrikes Tidningar* 24 November 1819), and in Umeå, Sweden, as 3:30 or 4 o'clock (meteorological observations by Eric Haeggquist) in the afternoon. It is probable that the reports described long-period earthquake effects in Kola on the fringe of the area of perceptibility. Significant long-period wave motions have been recorded from large-magnitude earthquakes also in Europe (Bungum et al. 2003).

The *Moscow Gazette* of 8 November 1819 repeated what was written in *Northern Post* of 27 October 1819 (both dates in old style). The three news items published in St. Petersburg are sufficiently similar to suggest a common origin. Possibly a messenger from the town of Kola arrived in Arkhangelsk, where the description appeared in writing on 25 September (old style) and from where it was sent onward to St. Petersburg. Figure 4 shows the postal route between the towns of Kola and

Arkhangelsk. It would have been possible to cover the whole distance on foot in the available time. No original documentation could be found among the incoming mail of September and October 1819 at the St. Petersburg branch of the Archive of the Russian Academy of Sciences. A possible explanation is that the note on the earthquake was sent to another administrative entity. Also, nothing may have survived to this day.

Norway

Aasvik (1985) provided oral recollections of the Lurøy earthquake in a local history book. They were preserved locally over many generations and collected in the areas of the strongest ground shaking. This book was also known to Muir Wood (1988 pp. 229, 231), but we list the previously disregarded place names of these recollections since they complement the data available in the epicenter region. An additional place name was picked up from a contemporary newspaper report. Table 1 shows that the newspapers in Norway often published the date of the letter and the name of its writer, contrary to the Finnish and Swedish press. A call for reliable accounts of the earthquake was published in the Norwegian newspaper *Trondhjems Adressecontoirs Efterretninger* of 3 September 1819. It prompted at least the long letter from Stadsbygd (Tables 1 and S1).

Intensity assessment

Figure 5a is the new macroseismic map of the Lurøy, Norway, earthquake of 31 August 1819. The respective MDPs are listed in Table 1. Its longer version with references and data for the available localities can be found in the electronic supplement (Table S1). Localities are villages or towns but not all are unambiguous. For example, the meteorological observations from Övertorneå include the remarks "the whole region" and "also in Lapland." The new map has more localities with the notation "felt" or with an uncertain intensity than the maps by Ambraseys (1985) and Muir Wood (1988) due to the lack of detailed data and the statistical nature of the European Macroseismic Scale used (EMS-98; Grünthal 1998). Intensities at localities with more ample data deviate less; for example, intensity I = 4 was assessed at Tornio, Finland, similarly to Ambraseys (1985; I = 4 MSK scale) and Muir Wood (1988; I = 4 MMI). Husebye and Kebeasy (2004 p. 63) downgraded the intensity in Tornio to "Felt (II?)," which is not supported by the data.

The remarkable environmental effects were concentrated in the sparsely populated Lurøy area and adjacent provinces in Norway (Muir Wood 1988 pp. 229–231). Instrumental investigations there provide further insight into the seismicity patterns in the area (e.g., Hicks et al. 2000; Janutyte et al. 2017).

We find no reason for lowering the maximum intensity below 8. The environmental diagnostics indicate very strong ground movement; however, they are not recommended to be used for assigning intensities on the EMS-98. The Environmental Seismic Intensity scale of 2007 (Serva et al. 2016) focuses on them. Vidrih et al. (2001) investigated the seismogeological effects of the M_L5.7 earthquake in Slovenia

in 1998 and attempted to link them to the EMS-98. They could assess damage to the buildings in the mountainous area affected in much detail, and they suggested large rockfalls to be indicative of intensity 8 on the EMS-98.

We have followed the guidelines in Grünthal (1998 pp. 95–96) and have not assigned intensities to localities with only effects on nature. General remarks of damage to the built-up environment are found in descriptions from the areas of strong ground shaking and include, for example, chimneys and walls knocked down, and also remarks about people and animals having difficulty standing. According to Brooke (1823 p. 263), "Some farms and several rocks were thrown down." We interpret this to mean that some farmhouses or farm buildings collapsed and that several rocks fell from the nearby mountains. Hough et al. (2000 p. 23,841) also refer to the term "thrown down" in relation to catastrophic damage to chimneys or whole houses during the New Madrid earthquake in December 1811.

Figure 5b shows a credible trend of intensity attenuation as a function of distance. The largest intensity outside Norway is I = 5–6 instead of I = 6 on the maps by Ambraseys (1985) and Muir Wood (1988). Value I = 4 has been assigned over a distance of several hundred kilometers. At almost 900 km from the epicenter, in Kola, Russia, the newspaper reports uncovered mention the lack of damage ("no negative consequences") and that "tables, chairs and other objects moved/oscillated in chambers rather noticeably." These classification criteria are similar to intensity I = 4 on the EMS-98; only "light furniture shakes visibly" in the guidelines is replaced by "oscillates," which is associated with longer periods. Faenza and Michelini (2011)

took a spectral acceleration of 0.3 seconds to be most characteristic of intensities I ≤ 4. If the duration of "two minutes" given for Kola bears any resemblance to reality, it suggests that the notion of pulse-like transient peaks of strong ground motion is not applicable to this locality.

Macroseismic magnitude

The magnitude of historical earthquakes is estimated using a regional equation connecting magnitude and area of perceptibility. Due to the rarity of moderate-to-large earthquakes in Fennoscandia, such equations can only be established there over a narrow intensity range. For example, Wahlström and Ahjos (1984) developed an equation for the macroseismic magnitude that is valid over intensities 3 to 6–7 (MSK and MMI) as follows

$$M_M = 0.38 + 1.14 \cdot \log r_F + 0.23 \cdot I_{max}, \quad (1)$$

where r_F is the radius of perceptibility in kilometers and I_{max} is the maximum intensity. Equation (1) gives $M_M \approx 3.7$ for the earthquake of 17 February 1819 with $r_F = 80$ km (Fig. 3).

Muir Wood and Woo (1987) used the isoseismal lines of many earthquakes on the Norwegian continental shelf in the first half of the 1900s and chose the surface-wave magnitude, M_S, since instrumentation was of medium or long period at the time. They

provided log-linear and non-linear equations using the area of perceptibility of intensity 4, A_4, as follows:

$$M_S = 0.90 + 0.81 \cdot \log A_4 \quad (2)$$

$$M_S = 1.57 + 0.63 \cdot \log A_4 + 0.0007 \cdot \mathrm{sqrt}(A_4). \quad (3)$$

In this investigation, intensity I = 4 was assigned to localities over a distance of hundreds of kilometers. Relatively ample data are available for Tornio and Stockholm at distances of approximately 510 km and 850 km from the epicenter, respectively. Equations (2) and (3) yield the values $M_s = 5.69$ and $M_s = 5.93$ for Tornio, and $M_s = 6.04$ and $M_s = 6.3$ for Stockholm, respectively, that is $M_s = 6.0 \pm 0.3$.

Intensity attenuation equations from tectonically similar regions can also be used to compare the estimated values with those in Table 1. For example, Bakun et al. (2003) developed the following equation to investigate historical earthquakes in eastern North America:

$$\mathrm{MMI} = 1.41 + 1.68 \cdot \mathbf{M} - 0.00345 \cdot \Delta - 2.08 \cdot \log(\Delta), \quad (4)$$

where Δ is the distance from the epicenter in kilometers, and **M** is moment magnitude. Equation (4) can be used to estimate a magnitude for each intensity–distance pair, and the final magnitude is the mean of the calculated values. Using the 29 data points available with a numerical intensity, the result is **M** = 5.85, assuming similarity

between MMI and EMS-98 intensities according to Musson et al. (2010). Rounding down all uncertain intensities (e.g., 4–5 was replaced by 4) gave **M** = 5.67 and rounding them up (4–5 was replaced by 5) gave **M** = 6.03, so the final magnitude accounting for the uncertainty of intensity assessment is **M** = 5.9 ± 0.2. The uncertainty of the epicenter does not affect the magnitude significantly.

Discussion

Investigating the Lurøy, Norway, earthquake of 31 August 1819 in essence means investigating communication routes. Eyewitness sensations and oral communications were written down and disseminated by correspondence from the area of perceptibility southward to the larger documentation and population centers. Technology had not yet advanced to make instant communication possible.

Previous research largely relied on contemporary newspapers. Uncovering much of the original correspondence in Finland and Sweden, and identifying the civil servants who wrote or collected reports of the earthquake effects, helps to establish the true timeline and authenticity of the observations. For example, Muir Wood (1988 p. 233) pointed out that the main source for earthquake effects in Stockholm, the newspaper report in *Inrikes Tidningar* of 24 November 1819, was published almost three months after the earthquake, "following the arrival of all the Norwegian news," casting some doubt on its reliability. Husebye and Kebeasy (2004 p. 61) repeated this argument and emphasized the absence of observations between Stockholm and the county of Västerbotten. The minutes of meetings at the Royal Swedish Academy of Sciences

show that observations from Stockholm, and also from the Swedish countryside, appeared in writing already in September. For the Russian territory, we found no original correspondence, but the uncovered national newspapers are more reliable sources than the Parisian newspaper cited by Ambraseys (1985) and Muir Wood (1988).

Prior to systematic macroseismic surveys, earthquake reports in Fennoscandia were often by-products of compilations of statistics and weather conditions (Mäntyniemi 2017a,b). The annual weather statistics of the Royal Swedish Academy of Sciences were therefore obvious sources to browse, and some remarks were indeed found. The records that have survived for different localities cover only sporadic time periods.

Another type of information is recollection. A new earthquake may awaken recollections of earlier occurrences, and rare and significant earthquake effects are preserved in oral tradition, as shown by Aasvik (1985). If the time of the earthquake is not known, recollections can rarely be used to define the event; however, for an earthquake with known origin time, recollections can be associated with it and give further data on the effects. In a low-seismicity region, larger earthquakes are seldom observed and may be preserved in the human memory (Mäntyniemi et al. 2011).

Series of administrative records adhere to the regulations and agenda, and are not promising sources of non-damaging earthquake effects. The minutes of the meeting of the municipality council in Sorsele, Sweden, are an anomaly in the sense that the response to the earthquake-related letter from the county governor was reported.

Coincidences that enhance reporting may also occur: Tornio, Finland, clearly benefited from the fortuitous timing of the tsar's visit.

County governor Georg Lars af Schmidt carried out his macroseismic survey in the Swedish county of Västerbotten. According to the minutes of the Swedish Academy, the reports were forwarded to the editors of the newspaper *Inrikes Tidningar*, and the trace is lost. Despite the missing data, the increased density of observations in Västerbotten demonstrates the difference between passively accumulating data and more systematic data collection. The call for observations in the Norwegian newspaper *Trondhjems Adressecontoirs Efterretninger* on 3 September 1819 can be regarded as an early attempt at macroseismic surveying.

The uncovered localities Gällivare, Sorsele, and Nikkaluokta in northern Sweden connect the data in the Lurøy region in Norway with those further eastward in Sweden and Finland (Figs. 1 and 5a). More resources are needed to explore whether the absence of observations north of Stockholm is rather an absence of data collection. Despite the irregular distribution of the data points, we see no reason to question their authenticity.

Thus the Lurøy, Norway, earthquake of 31 August 1819 is one example of an intraplate earthquake felt at long distances. Lamontagne et al. (1994) reported that the Mont-Laurier, Québec, earthquake of 19 October 1990 (m_{bLg} 5.0) was widely felt at distances of up to 500 km. The Kaliningrad earthquake in northern Europe on 21 September 2004 (M_w5.2) was felt at distances of up to 800 km (Gregersen et al. 2007). The maximum distance of a felt report was 1673 km for the Mineral, Virginia,

earthquake of 23 August 2011 (M_w5.8) in the eastern USA. Inside the extraordinarily large area of perceptibility, however, the earthquake was not felt everywhere relatively close to the epicenter (U.S. Geological Survey). The earthquake triggered rockfalls at distances of up to 245 km (Jibson and Harp 2012). In 1819, major landslides occurred in the epicentral region, and rockfalls were reported at least 100 km north of it (Muir Wood 1988). Their full extent is unknown because the regions were sparsely populated.

Conclusions

Due to the scarcity of moderate-to-large magnitude earthquakes in Fennoscandia, it is important for seismic hazard analysis that large pre-instrumental events are thoroughly investigated. The approach of historical seismology (preference for original documentation to copies of documents, contextualization of historical information) is particularly valuable in the case of sparse and irregularly distributed data points to establish their authenticity. The findings show that Kola and Stockholm remain crucial for understanding the extent of felt effects of the Lurøy earthquake and attenuation properties in Fennoscandia. The estimated magnitude of **M**5.9 ± 0.2, accounting for the uncertainty of intensity assessment, reconfirms the ranking of the earthquake as the largest onshore/nearshore earthquake in the seismicity record in Fennoscandia.

Data and Resources

The data used in this investigation were retrieved from the archived documents, newspaper press, and other published written sources listed in the references. Figures 1, 3, and 5a were made using the Generic Mapping Tools (www.soest.hawaii.edu/gmt; Wessel et al. 2013). Figure 5b was made using the Survo computing environment (www.survo.fi/english; Mustonen 1992). The documents uncovered are included in their original languages with translations into English in the electronic supplement. The supplement also includes a table of MDPs with references and data for the available localities.

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Figure captions

Figure 1. Location of European places mentioned in the text. The capital letters mark the towns in which newspapers were published in 1819.

Figure 2. Portraits of macroseismic data collectors in Sweden. a) County governor Georg Lars af Schmidt (1771–1842) in Umeå, photo: Mats Landin, Nordiska Museet. b) Academy member Jonas Henrik Gistrén (1767–1847) in Stockholm, painting: Fredric Westin (1782-1862), source: http://libris.kb.se/bib/12445599

Figure 4. The Russian North in 1824 (source: http://kolamap.ru/img/1824/1824.htm). The yellow line denotes the postal route between Kola and Arkhangelsk.

Figure 5. a) Macroseismic map of the Lurøy, Norway, earthquake of 31 August 1819. The respective data points are listed in Table 1. Table S1 in the electronic supplement contains the original data with references. b) Intensity–distance distribution of the macroseismic data points. The letter F stands for “felt.”

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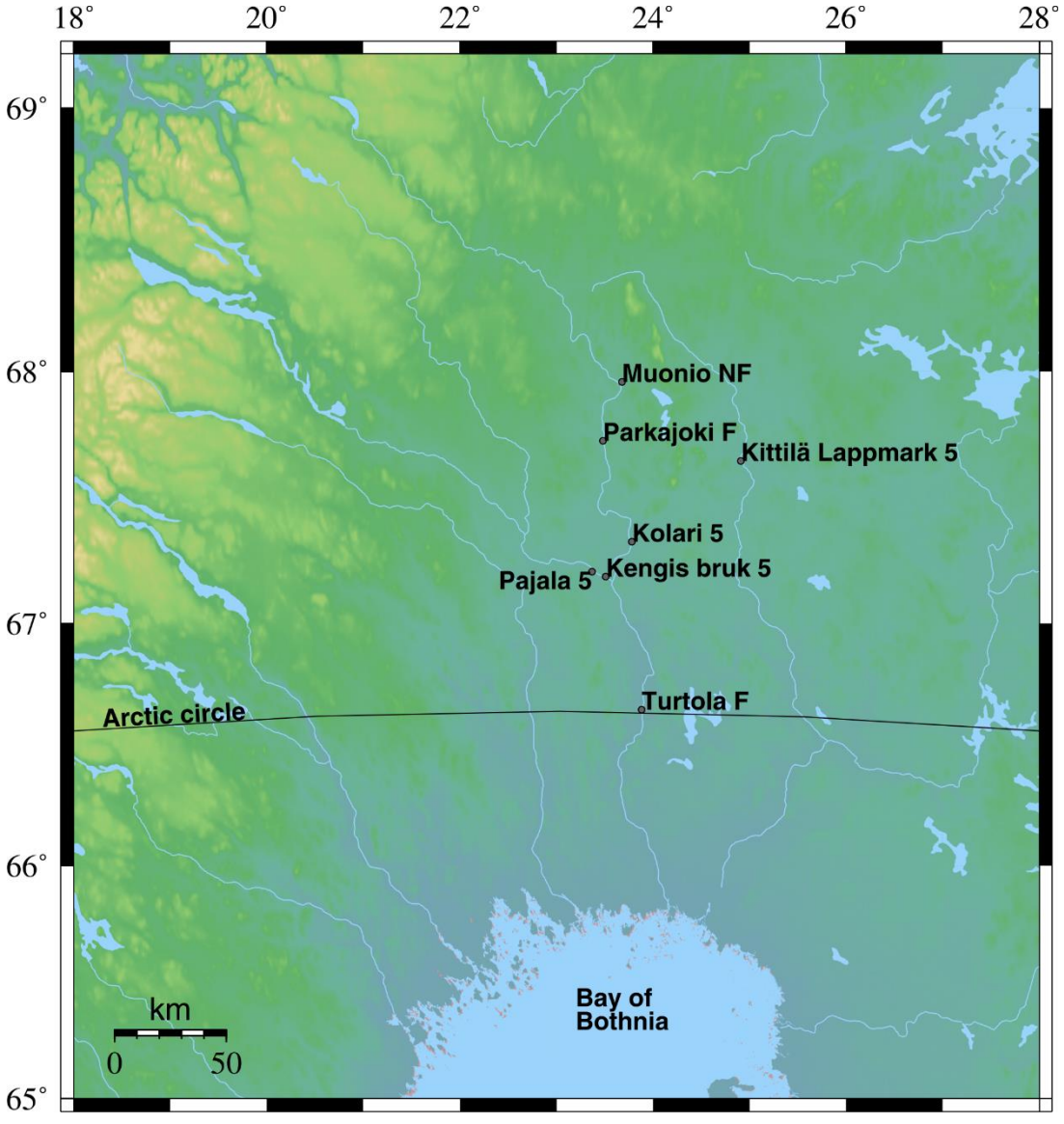
18°
20°
22°
24°
26°
28°
69°
68°
67°
66°
65°
Muonio NF
Parkajoki F
Kittilä Lappmark 5
Kolari 5
Pajala 5
Kengis bruk 5
Turtola F
Arctic circle
Bay of
Bothnia
km
0
50

Figure 3. Macroseismic map of the earthquake of 17 February 1819. The letter F stands for “felt,” NF for “not felt.” The earthquake was reportedly not felt south of the Arctic Circle.

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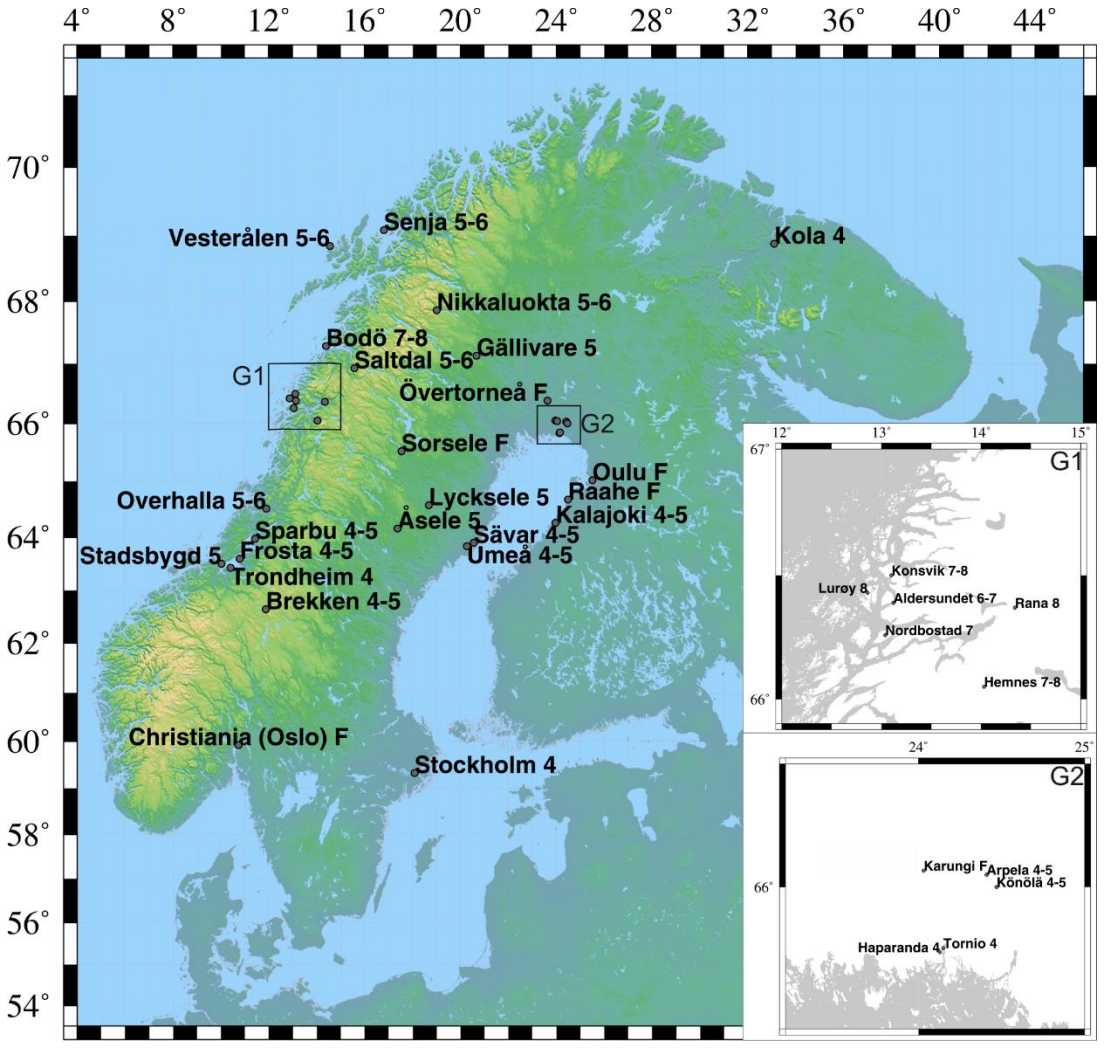

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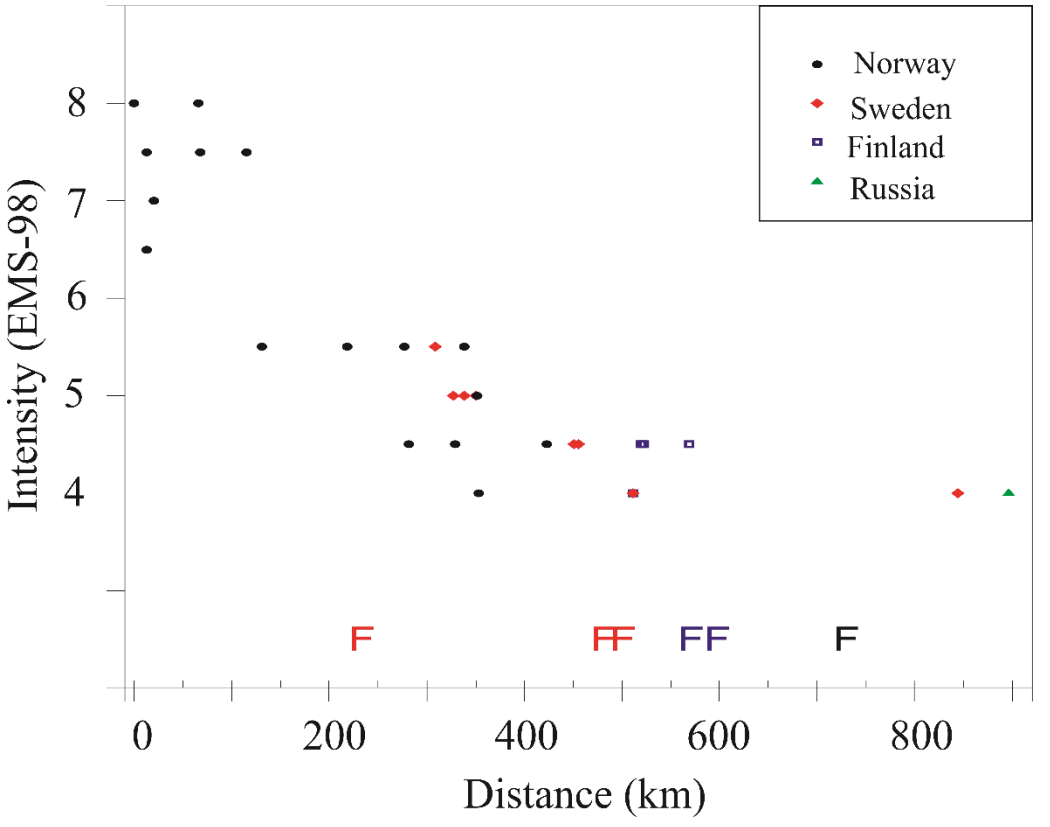

Figure 5. b) Intensity–distance distribution of the macroseismic data points. The letter F stands for “felt.”

A reappraisal of the Lurøy, Norway, earthquake of 31 August 1819

Päivi B. Mäntyniemi, Mathilde B. Sørensen, Tatiana N. Tatevossian, Ruben E. Tatevossian, and Björn Lund

Supplemental Material:

List S1. The uncovered documentation testifying to the Lurøy, Norway, earthquake of 31 August 1819 in the original languages with references and translations into English.

Table S1. Macroseismic data points of the Lurøy, Norway, earthquake of 31 August 1819 with references to the data available at the given locality.

List S1. The uncovered documentation testifying to the Lurøy, Norway, earthquake of 31 August 1819 in the original languages with references and translations into English.

Sweden

No. 1 Riksarkivet, Kungliga Vetenskapsakademien, Serie Protokoll, SE/SVAR/KVA-111010001/A/20 (1816-1820), Protokollet den 22 september 1819 (också i Digitala forskarsalen)

§ 8. *Landshöfdinge-Embetets i Umeå Embets Berättelse, om ett Jordskalf, som i nämnde stad och orten deromkring blifvit förmärkt, den 31 sistl. augusti. Som åtskillige Ledamöter förklarade sig äfven hafva iagttagit verkan af ett dylikt naturphenomen, både här i Hufvudstaden och i landsorterna, och sådant inträffat, som det synes på samma tid (timma) här, som i Umeå, ansåg Kongl. Academien dessa observationer förtjena att från säkra uppgifter samlas och anteknas.*

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 22nd September 1819 (also available in digital form)

§ 8. The account of the County Governor's Office in Umeå, about an Earthquake that was observed in that town and adjacent areas on the 31st of last August. Because many members told to have also observed effects of a similar natural phenomenon, both here in the capital and in the countryside, and they occurred seemingly at the same time (hour) here [in Stockholm] as in Umeå, the Royal Academy considered that these observations are worth to be collected from reliable sources and written down.

No. 2 Riksarkivet, Kungliga Vetenskapsakademien, Serie Protokoll, SE/SVAR/KVA-111010001/A/20 (1816-1820), Protokollet den 27 oktober 1819 (också i Digitala forskarsalen)

§ 10. *uplästes några bidrag til underrättelserna om det i Lappmarken äfven som här i Stockholm kände jordskalf d. 31 Aug. kl. emellan 3 och 4 e.m. insände af Landshöfdingen Schmidt i Umeå, samt af Acad. ledamot herr Gistren i Stockholm. Begärtes af Hr. von Rosenstein för att läggas til öfrige til*

Redactionen af Inrikes Tidningen inkomne handlingar i samma ämne, och skulle af dessa sedan et sammandrag göras för at i Acad. Handlingar förvaras åt efterverlden.

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 27th October 1819 (also available in digital form)

§ 10. some contributions to the reporting on the earthquake felt in Lapland and also here in Stockholm on the 31st Aug. between 3 and 4 p.m. were read, sent by County Governor Schmidt in Umeå and Academy member Mr Gistren in Stockholm. Mr von Rosenstein was asked to add them to those on the same topic that had arrived at the editorial office of *Inrikes Tidningar*, and a summary should then be made of all these reports to the *Proceedings* of the Academy, to be preserved for future generations.

Comments: The newspaper *Inrikes Tidningar* of 24 October 1819 published accounts of earthquake effects observed in Stockholm and in the province of Västerbotten, where the town of Umeå is situated. No report on this earthquake was ever published in the *Proceedings* of the Royal Swedish Academy of Sciences. The reports seem to have been forwarded to the editors of *Inrikes Tidningar*, and the trace is lost here.

No. 3 Riksarkivet, Kungliga Vetenskapsakademien, Serie Protokoll, SE/SVAR/KVA-111010001/A/20 (1816-1820), Protokollet den 2 februari 1820 (också i Digitala forskarsalen)

§ 5. *Uplästes några ytterligare från landshöfdinge-Embetet i Umeå inkomne rapporter om jordbäfningen i Lappmarken, hvilka skulle meddelas redactionen af Inrikes Tidningar.*

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 27th October 1819 (also available in digital form)

§ 5. Some additional reports from the County Governor's Office in Umeå regarding the earthquake in Lapland were read, and the editorial office of *Inrikes Tidningar* should be informed about them.

Comment: The newspaper in question did not publish anything on this earthquake after December 1819. It is unclear whether these reports have survived somewhere to modern time.

No. 4: Landsarkivet i Härnösand, Sorsele kyrkoarkiv SE/HLA/1010185/KI:1 (1789-1841) Socken-stämmoprotokoll (också i Digitala forskarsalen)

Protokoll den 29de November år 1819

§ 4. *Upplästes Konungens Resputive Befallningshafvandes Höggunstiga Skrifvelse af den 23je siste October, i Anledning af Wettenskaps Academiens Anmodan att lemna tillförliteliga uppgifter på den Jord Stöt som inträffade den 29de och 31e Aug hvarvid på väl Svenska som Lapska Allmogen yttrade sig att de haft känning af den samma den 31sta Aug och instämde med de uppgifter Rörande samma Jord Stöt Krono Lansmannen Westling på Befallning till Landshöfdinge embetet ingifvit.*

Translation: Regional State Archives in Härnösand, Sweden; Sorsele church archives SE/HLA/ 1010185/KI:1 (1789-1841) Minutes of the meetings of the municipality council (also available in digital form)

Minutes of the meeting on 29th November 1819

§ 4. The favorable letter of the County Governor, dated on 23rd of last October, was read, about the request of the Academy of Sciences to forward reliable accounts of the Earth Quake that occurred on 29th and 31st August, about which both Swedish and Lappish folk told to have felt of it on 31st Aug and these accounts agree with those regarding the same Earth Quake that Crown Police Chief Westling sent following the order of the County Governor's Office.

No. 5: Swedish newspaper *Stockholms Posten*, 29 December 1819, No. 302, p. 1

Utdrag af ett Bref från Luleå Lappmark, dat. Gelliware den 27 November 1819.

=== Den 31 Augusti eftermiddagen inträffade här en jordstöt, så att boningshusen darrade häftigt. Lappmän, som den tiden lägrade sig på fjällen nära Norrska gränsen, berätta, huru de med förundran och häpenhet der erfarit samma naturhändelse, samt att grytor och kittlar i deras kåtor stött tillsammans, och äfwen de obetydligaste buskar synbarligen rört sig.

Translation: Excerpt from a letter from Luleå Lapland, dated in Gelliware on 27 November 1819. === On the afternoon of 31 August an earthquake occurred here, so that dwellings shook violently. Lapp people, who at that time camped up in the mountains close to the Norwegian border, report how they experienced the same natural phenomenon and were astonished and amazed by it, and that pots and pans clattered together in their huts, and even the most insignificant shrubs visibly moved. **Comment**: The modern spelling of Gelliware is Gällivare.

No. 6: Riksarkivet, Kungliga Vetenskapsakademien, Meteorologiska observationer 1690-1923, Meteorologiska observationer till lands Sverige, SE/RA/420468/1/1a:51 Västerbottens län: P Stenberg, Väderleksanteckningar, Umeå landsförsamling, 1779-1823

1819

NB. den 31. Augusti, klockan omkring 3. eft: midd: kändes här ett märkeligt jordskalf, så häftigt att koppar kärlillen, som hängde på wäggarne darrade och klingade. Det tycktes komma ifrån wäster till öster och kändes ända ifrån Häradsskrifwaren Bergstedts gård ända till Comminister Nygren och Hedlunds gubben, samt påstod circa en ¼ minut. Om det hafwer Sträkt sig till nästgräntsande Byar wet jag ännu icke.

P St=g

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:51 County of Västerbotten: P. Stenberg, Weather notifications, Umeå rural parish, 1779-1823

1819

NB. On the 31st of August, approximately 3 o'clock in the afternoon, a noticeable earthquake was felt here, so strong that copper dishes that hung on the walls shook and rattled. It seemed to come from the west to the east and was felt from district registrar Bergsted's up to the deacon Nygren's place and the old man Hedlund's place and lasted for approximately a quarter of a minute. Whether it was observed in the contiguous villages I do not know yet. P St=g

Comment: The writer was Pehr Stenberg, deacon at the Umeå rural parish, also weather observer.

No. 7: Riksarkivet, Kungliga Vetenskapsakademien, Meteorologiska observationer 1690-1923, Meteorologiska observationer till lands Sverige, SE/RA/420468/1/1a:53 Västerbottens län: E. Häggquist m.m., Meteorologiska observationer, Umeå, 1809-1828

1819 Aug 31: *En lindrig jordbäfning kl. 4. e.m.*

Sammandrag År 1819: *Den 31 Aug. kl. ½ till 4 kändes en lindrig jordbäfning öfver alt.*

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:53 County of Västerbotten: E. [Eric] Haeggquist et al., Weather notifications, Umeå town, 1809-1828 [In the table of daily observations] 1819 Aug 31: A minor earthquake at 4 p.m.

Summary of the year 1819: On the 31 Aug. at 3:30 o'clock a minor earthquake was felt everywhere.

No. 8: Riksarkivet, Kungliga Vetenskapsakademien, Meteorologiska observationer 1690-1923, Meteorologiska observationer till lands Sverige, SE/RA/420468/1/1a:57 Norrbottens län: Meteorologiska observationer i Övre-Torneå (Haapakylä holme) av Johan Portin 1809-1822

1819 Aug 31 Jordskalf

Tabell Åtskillige Gjorda Anteckningar om Isgången, Årswäxten och Wäderleken uti Öfver Torneå Socken 1792-1826

Annotationer

1819: Den 31. Julii [sic] *märktes Jordskalf genom hela orten från S.O. till S.W. äfwen i Lappland, eller blott en jord darrning. Snö ej mycket.*

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:57 County of Norrbotten: Meteorological observations in Haapakylä, Övre-Torneå by Johan Portin 1809-1822

1819 Aug 31 Earthquake

Table Notifications on the amount of ice, shoots, and weather in the municipality of Öfver Torneå in 1792-1826

1819: on the 31st of July [*sic*] an earthquake was felt through the whole region from the southeast to the southwest also in Lapland, or merely an earthshaking. Not much snow.

Comment: The modern spelling of the locality Öfver Torneå is Övertorneå.

Additional: Landsarkivet i Härnösand, Västernorrlands läns landskansli SE/HLA/1030003/D III pa/9 1818-1820 Skrivelser från länsmän och landsfiskaler

Härads Rapport ifrån Indahls District af den 31sta Augusti 1819:

Natten emot den 29de i denne månad upkom hos Bonden Eric Ulin i Bäck en häftig vådeld, hvarigenom 2ne byggningar, en Träsk-Machin, 2ne fåhus [fårhus?] *jemte foderbod, Ett stall och ett wedlider, 10 Tunnor Tröskadt Korn, 8 Skylar Åker-Råg,* […]. *Varu och på hvad fått denna eldswåda upkommit, känner man aldeles icke.*

För öfrigt är härstädes, mig wetterligt, ingen ting anmärkningswärdt paßeradt.

Eric Adolf Dahne

Translation: Regional State Archives in Härnösand, Sweden; Administrative Department of the County Government in the county of Västernorrland, SE/HLA/1030003/D III pa/9 Reports from rural police chiefs and prosecutors 1818-1820

Report from the jurisdictional district of Indahl on the 31st of August 1819:

In the night preceding the 29th of this month a severe fire broke out in the house of peasant Eric Ulin in Bäck, in which two buildings, a tool / machine [of unidentified type], two sheep barns and storage sheds of feed, a stable and a woodshed, 10 barrels of dried corn, 8 shocks of seed rye, [… *a long list of items lost in the fire.*] Where and how the fire was caught is not known.

Otherwise, as far as I am aware, nothing special has taken place here.

Eric Adolf Dahne

Comments: This report is included here only because of the coincidence of dates. It was an obligation of police chiefs to report accidents, such as fires. It is difficult to judge if police chiefs would have reported an earthquake that did not cause any damage. The modern spelling of the district is Indal. This locality is not included in Table 1 or in Table S1 below.

Finland

No. 9: Kansallisarkisto, Helsinki: Senaatin asiakirjanippu sto kd 98/166 1819: selonteko maanjäristyksestä kaupungin maistraatilta, kirjoittajana pormestari Ephraim Cajanus

Tisdagen den 31. sistledne Augusti klockan emellan 3. och 4. på eftermiddagen, kändes här i Staden, lika som ock i Landsbyggden här intill, ett jordskalf, sträckande sig från Nordväst till Syd-ost, med en våglikt värckande rörelse å Byggnaderne, och hvaraf nästan alt hvad rörligt war, sattes i rörelse, dock utan att åskadkomma någon skada.

Torneå den 3dje September 1819.

På Magistratens wägnar E. Cajanus

Translation: National Archives, Helsinki, Finland: Senate documents sto kd 98/166 1819: a report of the earthquake from Tornio town administration to the Senate, written by mayor E. Cajanus

On Tuesday the 31st of last August between 3 and 4 o'clock in the afternoon here in the town, and also in the adjacent countryside, an earthquake was felt, propagating from the northwest to the southeast, a seemingly wavelike movement to the buildings, in which almost everything movable was put to movement, but without causing any damage.

Tornio 3rd September 1819

On behalf of the town magistrate, E. Cajanus

No. 10: Kansallisarkisto, Helsinki: Senaatin asiakirjanippu sto kd 98/166 1819: Alatornion kruununvoudin Jakob Heickellin raportista, päivätty 10. syyskuuta 1819.

(...) att en Jordskakning varit känd såväl i Torneå Stad som i trakterna på Ryska och Svenska sidan deromkring den 31. nästlidne Augustii klockan 3. efter middagen eller 3ne timmar före Hans

Kejserliga Majestäts ankomst till staden, som påstått ungefär ½ minut och förmärkts deraf att husen och alla Lösa meubler och käril skakat lika som vid något hårdt åskslag utan att likväl något buller eller Dån hörts. – Denne jordskakning har efter sammanstämmande berättelser sträckt sig ifrån Sydväst åt Nordost, emedan man upp efter Torneå Elf som löper i Söder och Norr icke känt deraf längre än 3. mil i Karungi men åt sidan i Arpela och Könölä byar har skakningen varit mera kändbar än kring Torneå och Haparanda.

Translation: National Archives, Helsinki, Finland: Senate documents sto kd 98/166 1819: extracted from the report by district bailiff Jakob Heickell to the Senate, dated on 10 September 1819.

(...) that an Earthquake has been felt both in the town of Tornio and adjacent areas in the Russian and Swedish parts on the 31st of last August at 3 o'clock in the afternoon, or 3 hours before His Imperial Majesty's arrival in the town, lasting about half a minute and noticed through the shaking of houses and all loose furniture and dishes as if during a heavy thunderstorm, only no noise or roar was heard. – This earthquake has according to accounts that tally with each other moved from the southwest to the northeast, because up along the River Tornio that runs in the south and north it was not felt further than Karungi 3 miles [Swedish miles, ~33 km] away, but on the side of the villages Arpela and Könölä the shaking was more discernible than around Tornio and Haparanda.

Comment: The remark "in the Russian and Swedish parts" refers to the fact that Finland was an autonomous Grand Duchy under the Russian tsar at the time.

No. 11: Oulun maakunta-arkisto: Tornion kaupunginarkisto, Kirjekonseptit 1810-1823, ABI:13; ote selostuksesta keisarin vierailusta, päivätty 18. syyskuuta 1819.

Tisdagen den 31: i samma månad kl. emellan 3 och 4: på eftermiddagen föregick Hans Keiserlige Majts ankomst, ett lindrigt jordskalf från Nord vest til Syd Ost, som likväl icke åstadkom någon skada, utan endast inbyggarnes förwåning öfver en hwåra orter så sällsyn händelse.

Translation: Provincial archives of Oulu, Finland: Tornio Town Archives, Letters of the town administration 1810-1823, ABI:13; an excerpt from a report by the town administration to the county administrative board regarding the visit of his majesty, dated 18 September 1819.

On Tuesday the 31st of the same month between 3 and 4 o'clock in the afternoon: the visit by his majesty was preceded by a minor earthquake that propagated from the northwest to the southeast, however not causing any damage, only the astonishment of the residents at such a rare happening in our areas.

Additional to nos. 9-11: Many reports of the tsar's visit were sent to the Senate in Helsinki. One bearing a resemblance to the wordings in texts 10-12 is reproduced below.

Source: Kansallisarkisto, Helsinki, Senaatti, Yleinen kanslia, Diaroimattomat saapuneet asiakirjat Eb:1 1809-1867, 1884-1885

Uleåborg den 12 Nov 1819

Några timmar före Kejsarens ankomst d: 31. Augusti till Torneå stad förmärktes ett Jordskalf som sträckte sig ifrån Nordvest till Sydost på några mils afstånd i närmaste tract af Torneå, och som väl ej var håftigt [sic. häftigt] eller långvarigt men lyftade alt hvad löst eller rörligt sants, och därigenom är än mera anmärkningsvärd, som detta var en här å orten alldeles ovanlig naturhändelse.

Translation: National Archives, Helsinki, Finland, Senate, General management, Non-registered received documents, Eb:1 1809-1867, 1884-1885

Oulu 12 Nov 1819

A few hours before the Emperor arrived in the town of Torneå [in Finnish: Tornio], an Earthquake was noticed that propagated from the northwest to the southeast up to a distance of a few miles [Swedish miles] in the proximity of Torneå, and that was neither strong or of long duration, but moved everything that was loose or movable, and is quite noteworthy because it was an unusual natural phenomenon in this region.

No. 12: Riksarkivet, Kungliga Vetenskapsakademien, Meteorologiska observationer 1690-1923, Meteorologiska observationer till lands Sverige, SE/RA/420468/1/1a:57 Norrbottens län: Meteorologiska observationer i Övre-Torneå (Haapakylä holme) av Johan Portin 1809-1822

Jordskalf. Samma Dag kl. 3 efter midd [?] den [?] 31. Kändes i Torneå Stad på Mattila och i Mäkelä samt i min stuga en Jordbäfning, min stuga knarkade och [?] liksom [?]gungade.

Translation: Swedish National Archives, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:57 County of Norrbotten: Meteorological observations in Haapakylä, Övre-Torneå by Johan Portin 1809-1822

Earthquake. The same day at 3 o'clock in the afternoon [?] 31 [?] an earthquake was felt in the town of Tornio at Mattila's and Mäkelä's as well as in my cottage, my cottage creaked and [?] kind of [?] swayed.

Comment: This excerpt is preceded by a description of his majesty's arrival in Tornio, so "the same day" refers to the 31st of August 1819. Some words could not be read, but three houses in Tornio are clearly mentioned.

No. 13: Finnish newspaper *Uusi Suometar*, 1 July 1882, No. 149, p. 2 (recollection)

Kalajoelta meille kirjoitetaan: Täällä tapahtui vähäinen maanjäristys kesäkuun 23 p. k:lo 8 aamulla. Täristys oli niin kova että meidän uutta kirkkoamme puisteli siksi että kalkitusta oli vähän varissut seinästä. Muutamissa paikoin se oli puistanut puuhuoneita, että ihmiset olivat pelosta juosseet ulos, ja toisissa paikoin aivan likellä asuvat eivät tienneet täristyksestä mitään. Ilma oli kaunis ja kirkas, jonka tähden ukkosta ei ensinkään kuulunut. Vanhain muistin mukaan ei ole tämänlaista tapausta ollut täällä, kuin vuotena 1818 elokuussa.

Translation: It is written to us from *Kalajoki*: A lesser earthquake happened here at 8 o'clock on the morning of 23 June [1882]. The tremor was strong enough to shake our new church so that a little bit of plaster fell from a wall. At a few sites it shook wooden rooms so that people became frightened

and run outdoors, and at other sites those living nearby did not notice any tremor at all. The weather was fine and clear, so no thunder was heard. According to elderly persons nothing similar has happened here, except for the year 1818 in August.

Comment: This likely refers to 1819.

No. 14: Kansallisarkisto, Helsinki: Asiakirjanippu sto kd 98/166 1819: ote Alatornion kruununvuodin Jakob Heickellin raportista senaatille, päivätty 10. syyskuuta 1819 (toinen ote samasta raportista, vrt. kohta 10)

Å sammanhang härmed och som ingen berättelse ännu torde inlupit om den mera betydliga Jordbäfning som den 17de sistledne Februarii kändes ofvan om Polar Circeln på ömse sidor om Torneå Elf, börjandes ifrån Turtola by ända up till Parkajoki 2. mil nära Muonioniska, på en sträcka af sexton mil ifrån söder till Norr, bör jag jemväl derom lemna den upplysning jag på återfärden ifrån min Lappska upbörds resa erhöll, nemligen: att uti Pajala och Kålare byalag samt vid Kengis bruk där skakningen varit starkast, hade omkring klockan elfva om natten sedan att folk redan, lagt sig, under något mulen men lugn väderlek ifrån Wester börjat höras sakta buller likt åskan, som inom en minut tilltagit så starkt att folket af förskräckelse upstigit, hvarefter husen under det starkaste dån börjat skäfva så att Lästar och från hvilka uti bonings porten varit uplagde på stänger [stånger?] *att torka nedrasat på golfvet samt murar och fönsterrutor söndersprucki*t, *hvilken våldsamma skakning varat ungefär en minut, hvarefter bullret som avancerat åt öster under en minut, småningom aftagit, så att hela katastrofen varat i tre minuters tid. På en sträcka af åtta mil ofvan och nedanom Pajala har bullret varit så starkt att all folk vaknat och upstigit, men nedanom Polar Cirkeln har ej något förmärkts ej heller vid Muonioniska kyrka, men uti Kittilä Lappmark öster ifrån Pajala och Kålare har äfven murar och fönsterrutor af skakningen söndersprucki*t, *hvaraf, jemte dånet, tydligen kan slutas, att den underjordiska Revolution som då förefallit, kommit ifrån Wäster och sträckt sig åt öster samt i bred demat söder och Norr intagit en sträcka af sextonmil.*

Translation: National Archives, Helsinki, Finland: Documents sto kd 98/166 1819: extracted from the report by district bailiff J. Heickell to the Senate, dated on 10 September 1819 (the second excerpt from the report, the first is no. 10)

In this context, and because no report yet seems to have been received on the more significant earthquake that was observed north of the Arctic Circle on both sides of the River Tornionjoki on the 17th of last February, beginning in the village of Turtola until up to Parkajoki 2 miles [~22 km] from Muonioniska, over the distance of 16 miles [~176 km] from the south to the north, supposedly I should pass on the information that I received when returning from my tax collection journey in Lapland, that is:

in the Pajala and Kålare village communities as well as at the Kengis factory, where the shaking has been the strongest, at approximately 11 o'clock in the night when folks had already gone to bed, in somewhat cloudy but calm weather conditions, a quiet roar resembling thunder was begun to be heard from the west, and in a minute it increased so strongly that folks got up out of fright, after which houses began to shake so that lasts which had been placed on rods above the house doors to dry fell down to the floor and stoves and windowpanes were broken, this violent shaking lasted for about a minute, after which the roar that propagated to the east diminished little by little, so that the whole occurrence lasted for three minutes. Within a distance of eight miles [~88 km] to the north and south of Pajala the roar was so strong that folks were awakened and got up, but south of the Arctic Circle nothing was observed, also not at the Muonioniska church, but in the Kittilä Lapland east of Pajala and Kålare also stoves and windowpanes were broken due to the shaking, from which, together with the roar, it can be inferred that the underground revolution seems to have come from the west and continued to the east and from the south to the north extended over sixteen miles [~176 km].

Comments: The modern spellings of Muonioniska and Kålare are Muonio and Kolari, respectively. The unit of distance is the Swedish mile, approximately 11 kilometers. This earthquake was of more local origin than the Lurøy earthquake of 31 August, so it is referred to as the more significant event

of the two in this area. According to Ambraseys (1985 p. 374), this earthquake was felt also in Norway, but we have not been able to verify this information.

Russia

No. 15: Russian newspaper *Le Conservateur Impartial* issued on 14 October 1819 (old style), No. 82 (26 October 1819 according to the new style)

Le 19 Août dernier à 5 heures du soir on a ressenti à Kola situé à l-extrémité septentrionale de la Laponie russe, 68° ½ de latitude (gouvernement d'Archangel) une légère secousse de tremblement de terre qui n'a duré que deux minutes; les effects ont été remarqués dans les maisons où les tables, chaises et lampes ont vacillé. Vers les dix heures l'horison a été sillonné d'éclairs, le tonnère a grondé sans pluie, et n'a cependant causé aucun dommage.

Translation: On the 19 of last August at 5 o'clock in the afternoon it was felt in Kola situated at the extreme north of Russian Lapland, 68°½ latitude (province of Arkhangel) a light shock of earthquake, which lasted for not more than two minutes; its effects were felt in houses where the tables, chairs and lamps oscillated. At ten o'clock the horizon was lighted by lightning, thunder was without rain, and this did not cause any damage.

Comment*:* The earthquake date is given according to the old style, which was 12 days behind the new one. The local time of the day differs from that given in text no. 16.

No. 16 Russian newspaper Сѣверная почта ('Northern Post') on 15 October 1819 (old style), No. 83

Изѣ АРХАНГЕЛЬСКА, омъ 25 Сенмлъря.

По известиям из Колы, 19 августа в половине 5 часа по полудни, при тихом западном ветре и влажной погоде, чувствуемо там было тихое колебание земли, продолжавшееся около двух минут. В сие время в покоях довольно приметным образом двигались столы, стулья и другие вещи. В 10 часу вечера примечено было из собравшейся на западе тучи великое сияние молний

с небольшим без дождя громом. Сии явления не сопровождались однако вредным последдствием для жителей Колы.

Translation: FROM ARKHANGELSK, on 25 September [old style].

According to the news from Kola, on 19 August at half of the 5th hour in the afternoon with a gentle western wind and humid weather, a light oscillation of earth was felt, lasting circa two minutes. At that time in chambers rather noticeably tables, chairs and other objects moved. And at 10 hours evening great lightning from the clouds gathered on the west with a little thunder without rain was noted. However, this phenomenon was not accompanied by any negative consequences for Kola habitants.

Comment: The expression of time, 'в половине 5 часа', literally means at half of the fifth hour. In the Russian language hours are regarded as ordinals and minutes indicate how much of the hour has passed. We regard this as a more reliable source for time of day than the text in French (no. 15).

No. 17: Russian newspaper *St. Petersburgische Zeitung* issued on 17 October 1819 (old style), No. 83 p.1

Archangelsk, vom 25. September. – Zufolge Nachrichten aus Kola ward daselbst am 19. August, bei schwachem Westwinde und feuchtem Wetter, eine leichte Erderschütterung verspürt, die gegen zwei Minuten anhielt. In den Zimmern wurden während dieser Zeit die Tische, Stühle und andere Möbeln merklich von ihren Stellen gerückt. Abends nach 9 Uhr ward in Westen bei belegtem Himmel starkes Blizen mit leichtem Donner ohne Regen bemerkt. Alles aber lief ohne die geringsten schädlichen Folgen für die Einwohner von Kola ab.

Translation: Archangelsk, on 25 September. – According to news from Kola on 19 August, under weak western wind and humid weather, a minor earthshock was noticed there that lasted about two minutes. In the rooms, during this time, the tables, chairs and other furniture were noticeably shifted from their positions. In the evening after 9 o'clock in the west on covered sky was noticed strong

lightning with minor thunder without rain. But everything passed without the least damaging consequences to the inhabitants of Kola.

No. 18 Russian newspaper Московские Ведомости ('Moscow Gazette'), No. 86, 25 October

Из Архангельска, Сентября 25.

По известиям из Колы, 19го Августа в половине 5го часа по полудни, при тихом западном ветре и влажной погоде, чувствуемо там было тихое колебание земли, продолжавшееся около двух минут. В сие время в покоях довольно приметным образом двигались столы, стулья и другие вещи. А в 10 часу вечера примечено было из собравшейся на западе тучи великое сияние молнии с небольшим без дождя громом. Сии явления не сопровождались однакож никаким вредным последствием для жителей Колы.

Translation: FROM ARKHANGELSK, on 25 September.

According to the news from Kola, on 19 August at half of the 5th hour in the afternoon with a gentle western wind and humid weather, a light oscillation of earth was felt, lasting circa two minutes. At that time in chambers rather noticeably tables, chairs and other objects moved. And at 10 hours evening great lightning from the clouds gathered on the west with a little thunder without rain was noted. However, this phenomenon was not accompanied by any negative consequences for Kola habitants.

Comment: This is an exact repeat of what was published in *Northern Post* (no. 16).

Additional: Ambraseys (1985) and Muir Wood (1988) used the French newspaper account given below for observations in Russia. The locality is misspelled, probably due to unclear handwriting in the original letter.

Parisian newspaper *Le Moniteur Universel* issued on 20 November 1819, No. 324

Russie, Petersbourg, le 23 octobre

─ *Le 31 août dernier, on a ressenti à Vrola, dans la Laponie russe, un trembelent de terre assez fort pour renverser les tables, chaises et autres meubles, sans cependant faire de dégâts plus considérables.*

Translation: Russia, St. Petersburg, 23 October

─ On 31 of last August, was felt in Vrola [*sic*], within the Russian Lapland, an earthquake strong enough to knock down tables, chairs and other furniture, despite that not causing more significant damage.

Norway

No. 19: Aasvik (1985) p. 40-41 (recollection)

I Aldersundet på garden Lien (gr 24) bodde den gang besteforeldrene til Peder Mikkelsen som hadde gården I begynnelsen av dette århundret. Fra ham har vi fortelling om at hans farmor, som kunne huske skjelvet, fortalte at det var så voldsomt at alle liene under Liafjellet fra Haugen og til de øvre Liamyrene ble dekket av stein som raste ned fra fjellet. Dermed ble alt slottland på denne strekningen, som til da var i årlig bruk, ødelagt. Hun fortalte videre at bølgene fra sjøen var så store at det var umulig å komme på sjøen i båt. Folket samlet seg da på et berg som heter Indreberget. Her mente de at rystelserne var mindre enn i Liagårdene. Det er ikke fortalt at mennesker ble drept eller skadet.

Translation: In Aldersundet, at the farm Lien (no. 24) lived at that time the grandparents of Peder Mikkelsen who had the farm at the beginning of this century. From him we have the story that his grandmother, who remembered the quake, told that it was so violent that all the hillsides under Liafjellet from Haugen to the upper Liamyrene were covered in rocks that fell down from the mountain. Thereby all farmland (orig. *slottland*) along this section, which until then was in yearly use, was destroyed. She further told that the waves from the sea were so big that it was impossible to go on the sea by boat. People then gathered on a mountain called Indreberget. Here they found that the shaking was less than in Liagårdene. There is no report about people getting killed or injured.

No. 20: Norwegian newspaper *Trondhjems Adressecontoirs Efterretninger* 14 Sep 1819, No. 74 (In the report from Stadsbygdens Prestegaard)

Den følgende Dag kom en Ven til Selskabet, som den Dag var 2 Mile borte herfra; ved at spørge om han havde mærket noget dertil, svarede han: Saa havde jeg dog Ret, skjøndt man modsagde mig – jo jeg følede udtrykkeligt at jeg blev gynget, og spurgte de Tilstedeværende om de intet følede, men de nægtede det. Denne hans Erfaring bestyrker mig i min Paastand, som jeg ytrede, at Bevægelsens Retning var Syd til Nord, thi Gaarden Foss, hvor han var, ligger 2 Mile nordenfor min Præstegaard.

Translation: The following day a friend joined the party, who on that day was 2 miles [Norwegian mile, about 11 km] from here; by asking if he had felt anything, he answered: Then I was right, though people disagreed with me – yes I clearly felt that I was swung, and asked those present if they did not feel anything, but they negated it. His experience strengthens my claim, which I spoke, that the direction of the movement was from South to North, since the farm Foss, where he was, is 2 miles north of my manse.

Additional: Norwegian newspaper *Trondhjems Adressecontoirs Efterretninger* 3 Sep 1819, No. 71 (This newspaper is also referred to as *Adresse-Avisen*.)

I Forventning af at fornævnte Optegnelse kunde være at erholde, ønskes og udbedes samme indsendte til Trondhjems Bogtrykkerie, saavel som enhver paalidelig Efterretning om Jordrystelsen den 31te f. M. i og ved samt fjernen fra Trondhjem, hvilke saavidt mueligt og uden Betaling indføres i disse Aviser.

Den 3die September 1819.

Translation: [preceded by remarks on the meteorological observations in Trondhjem in May and June] In the expectation that the previously mentioned record may be available, it is wished and asked that it is sent to Trondhjems Bogtrykkerie [Trondhjem's book press], as well as any reliable account of the ground shaking on the 31st last month in and near, as well as far from Trondhjem, which to the extent possible and without payment will be included in these newspapers. 3rd September 1819.

Table S1. Macroseismic data points of the Lurøy, Norway, earthquake of 31 August 1819 with references to the data available at the given locality. Macroseismic intensity is given on the European Macroseismic Scale of 1998. The coordinates are given as longitude °E, latitude °N. Distance is measured from the island of Lurøy, Norway. LT stands for large territory, the letter F for felt. The localities with new data are marked with an asterisk.

Country	**Locality** **(Coordinates)** **Distance**	**Documentary source:** ***translation from the original language*** **if not English**	**Remarks**	**Intensity**
Sweden	Åsele Lappmark (Åsele Lapland) (17.36,64.16) 328 km	**Newspaper** Inrikes Tidningar 24 Nov 1819: *On Tuesday 31st Aug., at a ¼ to 4 p.m., a similar shaking* [as two days earlier] *was felt* [in Åsele Lappmark], *but no roar was heard. The movement was stronger than in the previous one, so that teacups and glasses on a table were shifted from their position, and a teaspoon placed on a cup was thrown a span away* [14.5 cm]. *This shaking lasted for over a minute.*	LT, the coordinates are those of Åsele town The earthquake of 29 August 1819 is mentioned also in the description for Sorsele (no. 4 in List S1).	5
	Carl Gustav (23.97,66.05) 499 km	**Newspaper** Åbo Tidningar 15 Jan 1820: *This quake has not been felt in Tornio further north than 30 km from there up to Karungi or the church of Carl Gustaf (…)*	Carl Gustaf is not mentioned in the original account (no. 10 of List S1), and is not included in the MDPs.	No assigned MDP
	Gällivare* (20.66,67.13) 350 km	**Newspaper** Stockholms Posten 29 Dec 1819: *On the afternoon of 31 August an earthquake occurred here, so that dwellings shook violently.*	Alternatively F, because intensity depends on only 'shook violently'.	5
	Haparanda* (24.13,65.84) 511 km	**National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: *– This earth shaking has according to accounts that tally with each other moved from the southwest to the northeast, because up along the River Tornio that runs in the south and north it was not felt further than Karungi 3 miles* [~33 km] *away, but on the side of the villages Arpela and Könölä the shaking was more discernible than around Tornio and Haparanda.*	Haparanda and Tornio in practice form one town crossed by the country border. Haparanda is assigned the same intensity as Tornio.	4

		Tornio 10th September 1819 *J. Heickell*		
	Karungi* (24.03,66.04) 502 km	**National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: *– This earth shaking has according to accounts that tally with each other moved from the southwest to the northeast, because up along the River Tornio that runs in the south and north it was not felt further than Karungi 3 miles* [~33 km] *away, but on the side of the villages Arpela and Könölä the shaking was more discernible than around Tornio and Haparanda.* *Tornio 10th September 1819* *J. Heickell*		F
	Lycksele (18.68,64.58) 338 km	**Newspaper** Inrikes Tidningar 24 Nov 1819: *On the same day and at the same time an earthquake was felt also in Lycksele. The earth shook, houses creaked and groaned* [orig. husen brakade], *roofs creaked, looms in rooms swung; the church tower and chimney stacks seemed to totter.*		5
	Nikkaluokta* (19.01,67.85): Proxy for the location in the mountains; the Nikkaluokta Sámi group slaughter their reindeer there in early September 309 km	**Newspaper** Stockholms Posten 29 Dec 1819: *Lapp people, who at that time camped up in the mountains close to the Norwegian border, report how they experienced the same natural phenomenon and were astonished and amazed by it, and that pots and pans clattered together in their huts, and even the most insignificant shrubs visibly moved.*	The observations were made in temporary dwellings and/or outdoors.	5-6
	Övertorneå* (23.64,66.39) 479 km	**Swedish National Archives**, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468/1/1a:57 County of Norrbotten: Meteorological observations in Haapakylä, Övre-Torneå by Johan Portin 1809-1822: 1819: *on the 31st of July* [sic] *an earthquake was felt through the whole region from the southeast to the southwest also in Lapland, or merely an earthshaking.*	possibly LT	F
	Sävar (20.55,63.90) 456 km	**Newspaper** Inrikes Tidningar 22 Dec 1819: *an earthquake was felt at 3:15 p.m. in the village of Sävar and the municipality of Umeå, lasting for about 2 seconds and beginning with banging in junctions and walls, followed by a strong noise in the upper floors and attics of houses and then a shaking, so that many smaller gears on the walls began to move and the pile in the woodshed tipped over; the shaking was felt only in a given direction from the south to the north, in two,*		4-5

		in the southern end of the village, east of the river in the same route at the homesteads on the west side of the river, but nothing was felt at the homesteads east of the river.		
	Sorsele* (17.53,65.53) 234 km	**Regional State Archives in Härnösand, Sweden**; Sorsele church archives SE/HLA/ 1010185/KI:1 (1789-1841) Minutes of the meetings of the municipality council, meeting on 29 November 1819: *§ 4. Both Swedish and Lappish folk told to have felt of the ground shaking on 31 Aug*	An earthquake on 29 Aug is also mentioned in Åsele.	F
	Stockholm* (18.78,59.33) 844 km	**Newspaper** Allmänna Journalen 11 Oct 1819: *One person reading a book (at 3 p.m.) laying on a sofa, whose position in the room was from the North to the South, felt like falling backwards and rose up hurriedly and felt a shaking, which also appeared in the opposite house. Since he heard no gunshot, and another person in his household, when immediately asked, had not observed anything, he took it to be a spell of dizziness.* **Newspaper** Inrikes Tidningar 24 Nov 1819: *In the capital many have observed this natural phenomenon. Two persons sitting in armchairs, with their backs toward the south, felt a shaking or swaying from the east to the west, which made the head swing from one side to the other. This did not continue a full minute, and one of the persons observed some kind of suspension between the shakings. The walls and doorframes were heard to creak; chandeliers hanging in the ceilings swung from the east to the west; a woman drinking coffee had to hold on to the table and saw coffee spill from the cup, etc. – Two persons living on the fourth floor of a house in Norrmalm* [central Stockholm] *felt an unusual jolt or shaking. A subdued noise followed from one such swinging of the house, so that a tea-tray hanging on the wall began to shake fully and a book hold on to the hand almost fell due to the abruptness of the jolt. The earthquake lasted for 30 to 40 seconds, and its direction seemed to be from the northwest to the southeast. It began with a vertical jolt and came to an end with a horizontal slump, which became quite noticeable because the tea tray mentioned above finally moved half a span* [7.2 cm] *on the wall ….. This earthquake was also felt on the third floor of the house we live in, but in the lower part of the house it was hardly noticeable. – In general the shaking was stronger in the upper floors than in the lower ones.* **Swedish National Archives**, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 22nd September 1819: *§ 8. Many academy members stated to have observed effects of an earthquake, both in the capital and in the countryside, at the same time here* [in Stockholm] *as in Umeå*	Some of the academy members felt the earthquake ‘in the countryside’, which cannot be located.	4

		Swedish National Archives, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 27th October 1819: *§ 10. some contributions to the reporting on the earthquake felt in Lapland and also here in Stockholm on the 31st Aug. between 3 and 4 p.m. were read, sent by County Governor Schmidt in Umeå and Academy member Mr Gistren in Stockholm.*		
	Umeå* (20.27, 63.83) 451 km	**Swedish National Archives**, Royal Swedish Academy of Sciences, Series Minutes, SE/SVAR/KVA-111010001/A/20 (1816-1820), Minutes of the meeting on 22nd September 1819: *earth shaking observed in the town of Umeå and its surroundings* **Swedish National Archives**, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:53 County of Västerbotten: E. Haeggquist et al., Weather notifications, Umeå town, 1809-1828 [In the table of daily observations] 1819 Aug 31: *A minor earthquake at 4 p.m.* Summary of the year 1819: *On the 31 Aug. at 3:30 o'clock a minor earthquake was felt everywhere.* **Newspaper** *Inrikes Tidningar* 22 Dec 1819: *an earthquake was felt at 3:15 p.m. in the village of Sävar and the municipality of Umeå, lasting for about 2 seconds and beginning with banging in junctions and walls, followed by a strong noise in the upper floors and attics of houses and then a shaking, so that many smaller gears on the walls began to move and the pile in the woodshed tipped over; the shaking was felt only in a given direction from the south to the north, in two, in the southern end of the village, east of the river in the same route in the yards on the west side of the river, but nothing was felt in the yards east of the river.* **Swedish National Archives**, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:51 County of Västerbotten: P. Stenberg, Weather notifications, Umeå rural parish, 1779-1823: *A noticeable earthquake was felt here, so strong that copper dishes that hung on the walls shook and rattled. It seemed to come from the west to the east and was felt from district registrar Bergsted's up to the deacon Nygren's place and the old man Hedlund's place and lasted for approximately a quarter of a minute*	LT, includes reports from the municipality; the coordinates are those of Umeå town	4-5
Finland	Arpela* (24.41, 66.03)	**National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: – *This earth shaking has according to accounts that tally with each other moved from the southwest to the northeast, because up along the River Tornio that runs in the south and north it*	Information is given relative to Tornio.	4-5

	519 km	*was not felt further than Karungi 3 miles* [~33 km] *away, but on the side of the villages Arpela and Könölä the shaking was more discernible than around Tornio and Haparanda.* *Tornio 10th September 1819* *J. Heickell*		
	Kalajoki* (23.97, 64.26) 569 km	**Newspaper** Åbo Tidningar 15 January 1820: *in the municipality of Kalajoki this earthquake was accompanied by a roar. Houses shook during one minute, and heavier objects hanging loosely on the walls swung back and forth; in some sites people walking thought that the ground moved as kind of waves, and thus these movements, although more or less strongly, have been felt in the whole municipality of Kalajoki, which has the dimension of 10 miles* [1 Swedish mile ≈ 11 km] *from the southeast to the northwest, and it is told that the shaking moved in this direction in this district.* **Newspaper** Uusi Suometar 1 July 1882: [following a description of the earthquake on 23 June 1882] *According to elderly persons nothing similar has happened here* [in Kalajoki], *except for the year 1818 in August*	LT; the coordinates are those of Kalajoki town. The reminiscence from 1882 likely refers to August 1819.	4-5
	Könölä* (24.47, 66.0) 522 km	**National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: *– This earth shaking has according to accounts that tally with each other moved from the southwest to the northeast, because up along the River Tornio that runs in the south and north it was not felt further than Karungi 3 miles* [~33 km] *away, but on the side of the villages Arpela and Könölä the shaking was more discernible than around Tornio and Haparanda.* *Tornio 10th September 1819* *J. Heickell*	Information is given relative to Tornio.	4-5
	Oulu (25.50, 65.02) 598 km	**Newspaper** *Åbo Tidningar* 15 Jan 1820: *According to reports the earthquake was also felt in Oulu*	name in Swedish: Uleåborg	F
	Raahe (24.48, 64.68) 567 km	**Newspaper** *Åbo Tidningar* 15 Jan 1820: *According to reports the earthquake was also felt in Raahe*	name in Swedish: Brahestad	F
	Tornio* (24.15, 65.85) 512 km	**National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: *On Tuesday the 31st of last August between 3 and 4 o'clock in the afternoon here in the town, and also in the adjacent countryside, an earthquake was felt, propagating from the northwest to the southeast, a seemingly wavelike movement to the buildings, at which almost*		4

		everything movable was put to movement, but without causing any damage. *Tornio 3rd September 1819* *On behalf of the town magistrate, E. Cajanus* **National Archives, Helsinki, Finland**: Senate documents sto kd 98/166 1819: *(…) that an Earth shaking has been felt both in the town of Tornio and adjacent areas in the Russian and Swedish parts on the 31st of last August at 3 o'clock in the afternoon, or 3 hours before His Imperial Majesty's arrival in the town, lasting about half a minute and noticed through the shaking of houses and all loose furniture and dishes as if during a heavy thunderstorm, only no noise or roar was heard.* *Tornio 10th September 1819* *J. Heickell* **Provincial archives of Oulu, Finland**: Tornio Town Archives, Letters of the town administration 1810-1823, ABI:13 *On Tuesday the 31st of the same month* [August] *between 3 and 4 o'clock in the afternoon: the visit of his majesty was preceded by a minor earthquake propagating from the northwest to the southeast, however not causing any damage, only the astonishment of the residents at such a rare happening in our areas.* (dated 18th September) **Swedish National Archives**, Royal Swedish Academy of Sciences, Meteorological observations 1690-1923, Meteorological observations in the territory of Sweden, SE/RA/420468 /1/1a:57 County of Norrbotten: Meteorological observations in Haapakylä, Övre-Torneå by Johan Portin 1809-1822 *Earthquake. The same day at 3 o'clock in the afternoon [xxx] 31 [xxx] an earthquake was felt in the town of Tornio at Mattila's and Mäkelä's as well as in my cottage, my cottage creaked and [xx] kind of [xx] swayed.* [unclear handwriting]		
Russia	Kola* (33.08,68.88) 896 km	**Newspapers** Le Conservateur Impartial 26 Oct 1819, Сѣверная почта 27 Oct 1819, St. Petersburgische Zeitung 29 Oct 1819, Московские Ведомости 8 Nov 1819: *a light oscillation of earth was felt, lasting circa two minutes. At that time, tables, chairs and other objects moved in chambers rather noticeably. No negative consequences to the population.*	Long-period effects	4
Norway	Aldersundet* (13.12,66.39) Lurøy commune 12.4 km	**Aasvik (1985)** p. 40-41: *In Aldersundet, at the farm Lien (no. 24) lived at that time the grandparents of Peder Mikkelsen who had the farm at the beginning of this century. From him we have the story that his grandmother, who remembered the quake, told that it was so violent that all the hillsides under Liafjellet from Haugen to the upper Liamyrene were*		6-7

		covered in rocks that fell down from the mountain. Thereby all grassland [orig. slottland] *along this section, which until then was in yearly use, was destroyed. She further told that the waves from the sea were so big that it was impossible to go on the sea by boat. People then gathered on a mountain called Indreberget. Here they found that the shaking was less than in Liagårdene. There is no report about people getting killed or injured.*		
	Brekken village (Brække) (11.87,62.65) 423 km	**Newspaper** Trondhjems Adressecontoirs Efterretninger 21 Sep 1819: *On Tuesday the 31st August at 2 30 min Afternoon, the true time, we felt a shaking of the ground, which lasted for 30 seconds. The workshop, where I was staying, lurched very strongly, such that it was creaking everywhere; my two sons, who were staying in the loft above where I was sitting, felt it even stronger; everything hanging on the walls started moving. I have asked several people here in the area about this earthquake, but no one has felt anything. This is what I can report about the mentioned earthquake.* Writer: J. Dahlen, Dannebrogsmand.	At intensity levels 4 and 5 the ground shaking is not felt by everybody. At 5, a few feel the event outdoors.	4-5
	Bodö [Hundholm] (14.38,67.28) 115 km	**Brooke (1823)** p. 262-263: The shock of an earthquake, which is not very common in northern latitudes, was very severely felt at Bodöe on the 31st of August, 1819. Its duration was about a minute and a half, and it commenced with a report resembling a feu de joie. Some farms and several rocks were thrown down, the crest of one of which, overhanging the sea, I observed greatly shattered on my way to Löb. The captain of a small Russian vessel off Hundholm received so great a shock, that he instantly let fall both his anchors, and prepared to warp off, thinking the ship had run aground, when at the time, as he found afterwards, he was in 300 fathoms water. [1 fathom = 1.8228 meters]	Phrase 'thrown down' is interpreted as catastrophic damage.	7-8
	Christiania (10.73,59.92) 731 km	**Newspaper** Den Norske Rigstidende 22 Oct 1819: *It has been said that, at the same time, a shaking of the ground shall have been noticed in Christiania.*	Christiania is the former name of Oslo.	F
	Foss* (farm)	**Newspaper** Trondhjems Adressecontoirs Efterretninger No. 74, 14 Sep 1819, in the report from Stadsbygdens Prestegaard: *The following day a friend joined the party, who on that day was 2 miles from here; by asking if he had felt anything, he answered: Then I was right, though people disagreed with me – yes I clearly felt that I was swung, and asked those present if they did not feel anything, but they denied it. His experience strengthens my claim, which I spoke, that the direction of the movement was from the South to the North, since the farm Foss, where he was, is 2 miles* [22 km] *north of my vicarage.*	Combined to Stadsbygden. The unit of length is the Swedish / Norwegian mile ('mil'), which is about 11 km.	No separate intensity assessment
	Frosta (10.77,63.60)	**Newspaper** Den Norske Rigstidende 22 Oct 1819:		4-5

	329 km	*At Frosten, 2 miles* [22 km] *northwest of the town* [Trondheim], *it shall also have been felt, and that even stronger than in the town.*		
	Hemnes (Hemnäs) (14.03,66.05) 67 km	**Newspaper** Den Norske Rigstidende 10 Dec 1819: *According to incoming accounts, an unusually strong shaking of the ground was felt also in Hemnæs Præstegjeld in Nordlandende, at 2 ½ 67 afternoon on 31st August, accompanied by a hollow rumble, similar to a dull thunder; though this dull sound was much stronger that the strongest thunderclap. During this rumble, which lasted for about 10 minutes, partly before partly after and especially after the ground shaking, the ground was trembling extremely strongly for 4 minutes, such that one thought, that the windows would fall in; the milk, which according to custom is placed in rows under the ceiling in the farmer's living room was splashing out of the troughs; in some places the chimneys were damaged. Stor-Elven in Moe Annersogn was agitated as in the strongest storm. In several places the water was seen, both in the rivers and in Rans-Fjorden, rising up as a fountain, and accompanied by waves common for the strongest storm, though there was no wind in the air. After the sound of rumble the shaking seems to go from the East to the North, and the earthquake was felt 5-6 times in the same day and following night, though by far not as strongly. The curious thing about this earthquake is, that for 4 to 5 weeks the sound was heard almost daily, though always accompanied by a smaller* [orig. ulige] *ground shaking than the first time. The last time it was felt with certainty, was on 20th October. The weather this year has been extremely mild, and we have not seen frost until the last days of October. During the earthquake, which was felt in the night before 1st September, a field of barrel seed sank into the deep at the farm Storstrand by Ransfjorden; later fell piece for piece, such that 200 'alen'* ['alen' or 'aln' is a traditional Scandinavian unit of distance, about 60 cm] *of the man's farmed land has fallen out, thereby creating a drop* [orig. Leerfald] *of 30 'alen' height, and it is not further than 4 'alen' from his dwelling, which is why the village was rapidly summoned and helped him move the houses of the farm. The first sunken and in water transitioned field came up again during a smaller ground shaking some days later. The beach front is filled with clay, creating a long, pointy headland* [orig. udstikkende Odde]. **Heltzen (1834)** p. 61: At the farm Storstrand in Hemnæs district, located at the eastern bank of the large bay Utskorpen – this earthquake was devastating. The farmhouses were located at a large hill and at the foot of this, there was a non-negligible plain farmed with potatoes. – During the earthquake, this plain dropped together with the western part of the hill on which the houses stood. A very large 30-40 fathom ['favn', 1 favn=1.8288 m] drop was created in the mentioned hill and the plain below stood under water. The bank of the fjord, which was deep enough for the largest boats, was filled with gravel such that it was		7-8

		difficult to reach land. One neighbor had to, with the help of the people, move his farm.		
	Konsvik (Konsvikosen) (13.10,66.50) 13 km	**Aasvik (1985)** p. 41: *… And it is told that a man who worked with the hay in Konsvik felt the beginning quake.* *He should then hurry home to see how the family was doing. But the ground was waving such that he fell over several times, and it was impossible for him to run.*		7-8
	Lurøy (12.86,66.43)	Letter by Mr Dass, merchant, to the University of Christiania, repeated in **Keilhau (1836)** p.101: *On Luuröe in Helgeland, this earthquake was observed by Mr. Dass, who since has recorded the very frequent shakings, that occur in this region (see below). As far as it could be understood, the direction of the earthquake went from S. to N.; not only the houses were shaking, but also the surrounding mountains, from which large rocks fell down, such that they were surrounded by a dust of rock, as if they were surrounded by fog. Several springs, arising from the foot of the mountains, went unclear, as if they were mixed with milk, and their water was until on the third day undrinkable, even for the animals. The water had a smell of Sulphur, which was noticed at several places. The shaking lasted about 10 minutes (?!), since then shocks were felt every hour until 7 o'clock the next morning, but in the end weaker than in the beginning.* **Aasvik (1985)** p. 39: *From Lurøy farm, the innkeeper, merchant and skipper Isak Jørgen Dass reported to the University in Christiania that at 14:30 a strong roar was heard as from a distant thunder, and the houses were shaking. Rocks fell down from Lurøyfjellet in clouds of dust, and the water in the brooks turned so cloudy that the farm animals would not drink it for 3 days. Another account is from pastor Gabriell Smith Faye who in his description of Lurøy from 1836 expresses himself as this: «That the soils at several places are volcanic, seems reasonable from the frequent earthquakes occurring here, as well as it is shown that it contains Sulphur, which among others can be seen from, at a brook at Lurøy farm, springing at the foot of Lurøefjeldet, and with a lovely, crystal clear water, at the strong earthquake, which occurred in 1819, for several days gave a milk-white water, of strong Sulphur taste and completely undrinkable.»* **Heltzen (1834)** p. 61: *No, reports were given to me from Lurøe Fjerding and Trænøerne, where it has expressed itself as strongly if not stronger than by us. From the large summits in Trænen, rocks fell and at sea and in the*	With Selsøen and Træna	8

		sounds, rays of water were seen and many of those who were at sea, thought their boats would turn over.		
	Nordbostad i Nesna (13.04,66.26) 21 km	**Aasvik (1985)** p. 41: *From Norbostad in Nesna, Kristian Johansen (greatgrandfather of the author) told that his grandmother told about a shaking that was so strong that two horses that were ploughing in a flat field fell over in their furrows.*		7
	Overhalla / Overhalden (11.89,64.51) 218 km	**Newspaper** Trondhjems Adressecontoirs Efterretninger 21 Sep 1819: *On 31st August a rather strong ground shaking was felt at 2 ¾ afternoon, and lasted, decreasing, about 80 seconds. In Overhalden an old chimney fell down; at the first shock it was creaking in all houses, such that those, who were easily afraid, ran out – likely of fear that their houses would collapse. What was hanging on the walls, moved like a pendulum, and lose furniture was moved from its places. Such with confidence noticed.*		5-6
	Rana commune (Ranen) in Nordland county (14.34,66.37) 66 km	**Heltzen (1834)** p. 61: *It started around 2 ½ afternoon. For a long time, the air had been full of rainy clouds, when finally after 3 weeks of pouring rain the sky cleared. Everyone were busy saving the almost semi-rotten forage, lying on the ground. The sky turned the color of lead and a hollow, roaring sound was heard similar to, but much hollower, a distant thunder. The ground shook so violently that the windows shattered against the sun; in many places the walls on the roofs fell down and the hollow roaring sound in the air made the five minutes it lasted, terrible. In the mountain houses where the farmer had his milk standing on shelves under the roof, it splashed over. One saw on the completely calm Ransfiord rays of water standing high as a mast, and the water rose, even though the sea fell, over its highest flood banks. Some places, very fine sand was spraying up, it seems to be taken from the intestines of the Earth, since one has been looking for it with no success. The mountains were shaking so strongly that the weathered rock masses on their tops and from their sides fell down with much banging and as a rain of dust against the sun rays. The streams were cloudy from clay and soil. The ground shook so strongly that the people, who were out in the field, could not stand, since their knees would not carry them. This scene of horror lasted as mentioned for about 5 minutes and when it stopped came a violent hurricane from southeast which did not last longer than 10 minutes.*		8
	Saltdal (15.56,66.92) 131 km	**Newspaper** Den Norske Rigstidende 15 Oct 1819: *Saltdalens Præstegaard* [vicarage], *31st August. As the mail is departing now, I will not refrain from reporting the publishers of Rigstidenden about the strange act of nature, which occurred today the 31st August, namely an earthquake. In the afternoon at 2 ½ we were suddenly shocked by a rumble, similar to thunder, whereby also the house was shaking so strongly, that the windows were rattling, and the floor seemed to have a wave motion, when walking across it. The shaking seemed to come from the southwest, and to pull out of the fjord. The weather was very warm, without clear sunshine, and quiet. It was the first more or less clear day in the last 3 weeks, in which*		5-6

		southwesterly wind and rain has ruled constantly. The shaking lasted about 6 minutes, decreased successively, whereby the rumbling was heard longer than the shaking was felt. At the foot of the high mountain above the vicarage springs a stream of two springs in the mountain itself. The water in this turned completely white of clay, which is not observed at its banks; also this is usually not at all the case, not even during spring flooding. By further investigation it was found, that the water sprang out from the foot of the mountain, which seemed clearly to show, how the shaking has worked in the lap of the Earth. Towards 5 o'clock, another very weak movement was felt, whereby the sound was stronger. As I sit and write this, a new shaking starts, at 7, 5 min. It was weaker than the first and lasted 3 minutes, though the house was shaking. In September 1814 earthquakes were felt as well here and in the surrounding regions, which were first observed at night and then the next day weaker a couple of times. The first of those events was stronger than now. *Sommerfelt.* **Aasvik (1985 p. 40)** also refers to this account and claims that it is from Rognan in Salten: *At Rognan in Salten lived the well-known priest and botanist S.C. Sommerfeld, who reported that he here at 2.30 on 31. August suddenly was scared by a strong rumble from west-southwest, and the floor was as in a wavelike motion. The water in nearby streams became cloudy from clay, and some old stone walls fell down.*		
	Salsøen	**Newspaper** Tromsø Stiftstidende 1 May 1842 (repeated in Kolderup 1913 p. 49): *I fully admit that the shaking was stronger below the Arctic Circle. – A large yacht from this region (southern Senjen) passed at exactly the same time the passage between Mangvarene and Salsøen. There the shaking was so strong at sea, that the ship kind of stopped, and shook like a leaf, with creaking and banging, as a great fright for the crew, who did not immediately understand the reason.*	Newspaper *Tromsø Stifstidende* (*Tromsø Tidende*) was established in 1838. Combined to Senja (Senjen)	No separate intensity assessment
	Selsøen	**Newspaper** Tromsø Stiftstidende 1 May 1842 (Kolderup 1913): *In Selsøen – 1 mile* [11 km] *from Lurø – stones fell down from the chimneys, and caused damage. Here, contrarily, no movement was noticed at the sea.*	Combined to Lurøy	No separate intensity assessment
	Senja (island) (16.80,69.08) 338 km	**Newspaper** Tromsø Stiftstidende 1 May 1842 (also in Kolderup 1913 p. 49): *On the occasion of Professor Keilhaus' statement – or opinion – about the earthquake in Nordland on 31st Aug. 1819, which is included in this paper No. 17 this year, which says: "That the earthquake on one side (of the Arctic Circle) does not seem to have been felt north of Salten" – a contributor hereby takes the liberty to inform, that it was felt throughout all of Senjen, at about 3 afternoon, and in some places, the shaking was so strong that the pots were dancing on the pot hooks in the stove* [orig. i Skjeringerne paa Skorstenen]*, and the furniture was moving in the rooms, which was also the case in Vesteraalen.*	The current spelling of Senjen is Senja.	5-6

	Sparboen (11.43,63.97) 281 km	**Newspaper** Trondhjems Adressecontoirs Efterretninger 10 Sep 1819: *Bruum in Sparboen, on 4th Sep. 1819.* *On 31st August at 2 ¾ afternoon a strong earthquake was noticed at the farm Strugsted and several places in Sparboen, which lasted about ½ minute and was accompanied by some roaring.*	Modern spelling Sparbu.	4-5
	Stadsbygd (10.02,63.51) 351 km	**Newspaper** Den Norske Rigstidende No. 78, 28 Sep 1819: *About 2 miles from Trondhjem at Stadsbygdens Præstegaarad* [vicarage] *occurred on the 31st last August, at 3 ¼ afternoon, an earthquake, which separated in two shocks, of which the first, which lasted 2 to 3 minutes, was waving, from south to north; the second, which lasted 1 minute, was weaker and only quaking; in between both was a break of 1 minute.* **Newspaper** Trondhjems Adressecontoirs Efterretninger No. 74, 14 Sep 1819: *Stadsbygdens Præstegaard [Stadsbygd vicarage]* *8th Sep. 1819.* *Following the request in Adresse=Avisen No. 71 d.A. I hereby report to the Newspaper reception the following account of the earthquake 31st last August, as far as it was noticed here:* *At 3 ¼ in the afternoon, when a party of some friends was dining with me, the table started moving strongly – we ate in a large room on the second floor, and by looking at the movement, almost everyone thought, that either I or someone else, for fun, set the floor of the room in motion; we talked about it, and everyone refused his contribution to the movement. My oldest daughter stood near the large round dining table, and was seen by everyone in a strong dancing movement; people said: the maid is standing there dancing, to which she replied yes I do so. I found it as impossible for her to generate such motion, as I found it contradicting to good behavior, if she had done it, and I became more aware, whereby I clearly felt that the movement was waving; this gave me the assurance that it had to be an earthquake, which I expressed for the party, without anyone opposing, though most thought the whole issue was a joke by either me or someone else. I will conclude that this waving shaking lasted about 2 to 3 minutes, since we talked about it, looked at each other, guessed and joked about the movement, and it became stronger, until it suddenly stopped. After 1 minute it came back, but weaker and of short duration, as it also was not waving, but only quaking. After some hours we heard from the neighboring farm Fenstad that the living room there had creaked, and that lime had fallen from the wall, during the shaking. One of my sons had been in a storehouse, and had to flee from there, as he thought it*		5

		would fall over with him; in another of my storehouses, the door sprang open – and so we were convinced that the shaking was an act of nature, and neither of me or my guests. [Foss farm, see above] *The result of it all is then, in my opinion: The earthquake occurred on 31st August at 3 15 minutes afternoon, separated in two shocks, the first lasting 2 to 3 minutes, was waving, from south to north; the other 1 minute, weaker, and only quaking; between both was a break of 1 minute.* *Rønne.*		
	Træna (12.03,66.51) 38 km	**Heltzen (1834)** p. 61: *No, reports were given to me from Lurøe Fjerding and Trænøerne, where it has expressed itself as strongly if not stronger than by us. From the large summits in Trænen, rocks fell and at sea and in the sounds, rays of water were seen and many of those who were at sea, thought their boats would turn over.*	This is a location west of Lurøy.	No separate intensity assessment
	Trondheim (10.39,63.43) 353 km	**Newspaper** Den Norske Rigstidende 22 Oct 1819: *Trondheim, 8th October – In Rigstidenden is already told, that on 31st August last in the afternoon a not insignificant ground shaking was noticed at Stadsbygden, especially in the vicarage at this location. On this occasion it further deserves to be noted, that this ground shaking also occurred in Trondhjem town, 2 miles* [20 km] *south of Stadsbygden, and in this city's surrounding, exactly at the same time as in Stadsbygden, though not entirely as strongly.*		4
	Vesterålen (14.54,68.84) 277 km	**Newspaper** Tromsø Stiftstidende 1 May 1842 (also in Kolderup 1913, p. 49): *… it was felt throughout all of Senjen, at about 3 afternoon, and in some places, the shaking was so strong that the pots were dancing on the pot hooks in the stove, and the furniture was moving in the rooms, which was also the case in Vesteraalen* [Vesterålen].		5-6